e040082 SBI/NORDA (2)

AESOP 2.1 Expert System Users Manual

J. E. Peak
Computer Sciences Corporation
Monterey, CA 93943-5006

Prepared for
Atmospheric Directorate
Monterey, CA 93943-5006

Approved for public release; distribution is unlimited. Naval Oceanographic and Atmospheric Research Laboratory, Stennis Space Center, Mississippi 39529-5004.

ABSTRACT

AESOP -- An Expert system for Shipboard Obscuration Prediction -- is a knowledge-based computer program that provides forecasts of maritime fog and haze. This users manual provides information on AESOP operation, discusses such features as the explanatory interface and the data modification/rerun options; and provides guidance on accessing AESOP's marine climatology, changing system units, and running AESOP from data sets.

ACKNOWLEDGMENTS

The author gratefully acknowledges the support of the sponsor, Naval Ocean Systems Center, Dr. J.H. Richter, Program Element 62435N, for making this effort possible.

TABLE OF CONTENTS

Page

1. Scope 1

1.1 Identification 1
1.2 System Overview 1
1.3 Document Overview 1

2. Referenced Documents 1

3. Execution Procedures 2

3.1 Overview 2
3.2 Starting AESOP; Top-Level Menu 2

3.2.1 Making a Forecast 3
3.2.2 Hypsometric Equation Calculator 4
3.2.3 Inversion Types 4
3.2.4 Inversion Strengths 4
3.2.5 Data Summary Display 5
3.2.6 Nowcast and Forecast Displays 5
3.2.7 Invoking the Explanation Feature 6
3.2.8 Modifying Parameters for a Case 8
3.2.9 Running a New Case; Exiting from Forecast Mode 9

3.3 Accessing the Marine Fog Climatology 9
3.4 Changing the System's Units 9
3.5 Running Test Sample Cases 10
3.6 Exiting from AESOP 11

4. Error Messages 11

AESOP 2.1 EXPERT SYSTEM USERS MANUAL

1. SCOPE

1.1 Identification

This Users Manual applies to the expert system known as "An Expert System for Shipboard Obscuration Prediction" (AESOP) Version 2.1. AESOP is currently available in two slightly different forms; one that runs on an IBM-PC or compatible, and one that runs on the MASSCOMP 5450.

1.2 System Overview

The main purpose of AESOP is to provide short-term (1 h) and long-term (6 h) forecasts of fog and haze at sea. Other AESOP features include a complete explanation of the forecast reasoning to enhance the expertise of the user, as well as a maritime fog climatology.

1.3 Document Overview

The purpose of this manual is to provide users of AESOP instructions sufficient to execute the program and measures to be taken if error messages occur.

2. REFERENCED DOCUMENTS

Peak, J.E., 1989: An evaluation of the AESOP 2.1 Expert System. Naval Environmental Prediction Research Facility[1], unpublished contractor report, Monterey, CA 93943, 18 pp.

Peak, J.E., and P.M. Tag, 1989: An expert system approach for prediction of maritime visibility obscuration. Mon. Wea. Rev., **117**, 2641-2653.

---

1. Now the Naval Oceanographic and Atmospheric Research Laboratory, Atmospheric Directorate.

Rogers, C.W., 1988: North Atlantic fog forecasting TESS program performance specification. Naval Environmental Prediction Research Facility[2], unpublished contractor report, Monterey, CA 93943, 17 pp.

3. EXECUTION PROCEDURES

3.1 Overview

This section provides the information and instructions necessary for user interaction with AESOP 2.1 in order to carry out its operation. Most of the program execution is self-explanatory, so the emphasis here will be on situations and features the user may not be aware of from ordinary use of the program.

3.2 Starting AESOP; Top-Level Menu

AESOP is invoked by typing "aesop" at the command-line prompt. After introductory screens (not shown) are displayed, the user reaches the top-level menu (Fig. 1). The figures presented in this manual (see pp 13-22) apply to the PC-based version. The menus in that version are graphics-based and list a set of choices with a lighter-colored bar that can be moved over the desired selection via arrow keys. Alternately, the user can select the numerical position of the desired response, or even its first letter. Caution should be used in the last approach since, when more than one choice begins with the same letter, the program would always choose the first one. A quick way to jump to the top or bottom of a list of selections is to use the "Page Up" and "Page Down" keys.

The current MASSCOMP version does not yet have a graphics

2. Now the Naval Oceanographic and Atmospheric Research Laboratory, Atmospheric Directorate.

capability. Therefore, its menus present the choices as numbered lists (Fig. 2). The user simply enters the number of the desired item in this program version.

3.2.1 Making a Forecast

The user will usually choose the first item of the top-level menu (Fig. 1). This selection leads to an AESOP consultation session and a resulting forecast. The user simply responds to a sequence of questions, selecting or entering the data requested. Some of the data requires a numerical value to be input. For example, the first two items AESOP requests are the latitude and longitude of the forecast location (Figures 3 and 4). Notice that if the user wants to indicate a latitude of 58.8 degrees north, he can enter "58.8n" and AESOP will parse the answer automatically. Even "58.8N" works as well. Alternately, one could enter "58.8" and AESOP would prompt the user separately for the hemisphere designation. If the user enters a value that is outside of the normal range (for example, a latitude of 95 or -20 degrees), AESOP will state that the value is not allowed, and will repeat the prompt for a correct value (Fig. 5). Such a check for reasonable values occurs whenever numerical input is required (e.g., for temperatures and wind speeds).

Most of the information required by AESOP is presented in the form of menus. For example, the synoptic situation (Fig. 6) is specified by selecting from among seven choices. Other information is of the "yes/no" variety; for example, whether or not a frontal passage will occur (Fig. 7).

3.2.2 Hypsometric Equation Calculator

One special case is when AESOP asks the user to enter the inversion base height (Fig. 8). If the user knows the pressure-level of the inversion, but not the actual height, he can invoke a hypsometric equation calculator by entering "H". AESOP will ask the user to enter the pressure level of, 1) the surface, 2) the inversion base, and 3) the estimated mean temperature in the layer just specified. The inversion base height is then calculated internally and added to the AESOP data base.

3.2.3 Inversion Types

Another special case involving inversions is the inversion type (Fig. 9). C. William Rogers, the principal source of expertise for AESOP, determined that there are three types of inversions that lead to different fog situations (Rogers, 1988). Since most users will not be familiar with his categories, the novice user can choose here to look at examples of the three types (Fig. 10). These inversion types are delineated by their vertical structure. Type 1 inversions are surface inversions. Type 2 inversions are surface inversions with a stronger inversion aloft. Type 3 inversions occur above the surface (Fig. 10).

3.2.4 Inversion Strengths

When an inversion is present, the user is asked to specify its strength (Fig. 11). There is no exact measure of inversion strength, and the user is invited to develop his own heuristic expertise in categorizing the inversions he experiences. For the purpose of the AESOP 2.1 evaluation (Peak, 1989), the author used the following heuristic. **Weak inversions have a temperature**

difference of less than 2°C between the inversion base and the inversion top. Moderate inversions range between 2 and about 5°C, while a strong inversion has a temperature difference greater than 5°. While these values represent rough guidelines, the user should, with experience in using AESOP, be free to develop his own.

3.2.5 Data Summary Display

If, during the question/answer phase, the user mistakenly enters an incorrect value or selection, he is given a chance later to modify his responses. Once AESOP has the complete information it needs, it displays a summary of that information (Fig. 12). The user can select one or more items to change here until he is completely satisfied that he wants AESOP to proceed with the forecast. When one data item change affects other data, AESOP automatically calculates the new value or prompts the user for the required information. For example, if the temperature or dewpoint is modified, AESOP automatically calculates the new relative humidity. For another example, if the user originally responded that there was no inversion, and then decided that there was an inversion, AESOP will ask all of the additional questions involving the inversion structure as well.

3.2.6 Nowcast and Forecast Displays

When the user tells AESOP to proceed with the forecast (Fig. 12), there is a slight delay while the rule base is invoked followed by the AESOP nowcast (Fig. 13). The topmost item is the nowcast validation time, the nowcast obscuration state (Fog, Haze or No Obscuration) and the rule-base probability of that nowcast.

AESOP does not often hedge on a forecast -- the probability of the chosen obscuration state is usually pretty large.

After the nowcast selection, a nutshell summary of the nowcast reasoning is presented whenever the nowcast indicates a change in the status quo (Fig. 13). In other words, when AESOP thinks the situation will change, it says why; otherwise, no explanation is needed. AESOP has an internal probability for all three obscuration states. These three states and the probability of each are presented next (Fig. 13). In general, AESOP chooses as its nowcast the obscuration state with the highest probability. There is one major exception involving fog. Since fog is a much more restrictive obscuration to visibility, any fog probability of at least 50% leads to a fog forecast, even though the haze probability may be much larger.

3.2.7 <u>Invoking the Explanation Feature</u>

At the bottom of the nowcast screen (Fig. 13) is a menu of actions to be taken next. The first option is to display a screen just like this one only for the AESOP 6 h forecast. The next choice is to follow the nowcast chain of reasoning. Selection of this item leads to AESOP's state-of-the art explanation feature. To understand how this feature works, one must keep in mind that AESOP is a rule-based expert system. Each rule involves taking known information and drawing a conclusion. Such conclusions then become part of the set of known information such that further conclusions can be made. This process is referred to as the "chain of reasoning." As conclusions are made, an internal record of the chain of reasoning is kept. The explanation feature is the user's window to this record.

If one keeps in mind that each step in the record is a separate conclusion based on separate information, one can glean a complete understanding of what AESOP expects will and won't happen and why. An example is presented in Fig. 14. The explanation text appears (in the PC version) in a pop-up window overlaying the forecast screen.

For an initially hazy situation, the explanation feature begins with the top-level conclusions "Fog will form," "The haze will persist" and "The haze will dissipate" (Fig. 14). These items simply mirror the three potential obscurations already presented just after the nutshell summary (Fig. 13). When the associated probability is low (high), it means that this conclusion was not (was) supported by the data. Thus, if the user is interested in why fog will not form or why the haze will not persist, he can select the conclusion "Fog will form Prob: 0%" or "The haze will persist Prob: 0%", respectively. In this example, the user is interested in why the haze will dissipate and makes that selection.

The AESOP explanation feature looks at what information was used to make that conclusion and displays it (Fig. 15). The conclusion being explained is reiterated at the top of the explanation screen. Next is a short description of the reasoning. Here, we see that it is the sunny conditions that led to the conclusion that the haze would dissipate. Following the chain of reasoning, AESOP next lists the factors that lead to this conclusion; in this case the single fact that the sun will be high enough (Fig. 15). If the user explores how that fact became known (by selecting it in the menu at the bottom), he will see (Fig. 16) that the sun angle at the forecast time is calculated to be 50 degrees above the horizon. Since there are no contributing factors listed here, we have reached the end of a single chain of reasoning.

One could back up and follow the other reasoning chains that support or disprove other conclusions. In a separate example (Fig. 17) the user wants to see why Taylor fog was not forecast. Here, AESOP explains that there are three factors that must all be determined to be true before the Taylor fog conclusion can be made. One can see from the zero probability values that the marine layer is not primed for fog and the marine layer will not be cooled from below to dewpoint (Fig. 17). Thus, even though there is some sustained cooling from below (as evidenced by the 100% probability), Taylor fog cannot form for the other two reasons. Thus, looking at the low probabilities tells the user "why not" and looking at the high probabilities tells the user "why."

3.2.8 Modifying Parameters for a Case

On the nowcast or forecast screens (Fig. 13), one choice in the bottom menu is to modify the parameters entered for this case and then rerun the forecast. Selection of this item returns the user to the summary screen (Fig. 12). As described in Section 3.2.5, one or more items can be changed, followed by a new AESOP forecast. Thus, the user can explore "what if" situations to see the effect on the forecast of changing various data inputs.

3.2.9 Running a New Case; Exiting from Forecast Mode

If the user wants to run a completely new case, he can select that menu item in the nowcast or forecast display (Fig. 13). AESOP clears its internal database and the program control shifts back to the beginning of the question/answer sequence. Alternately, if the user is done with the AESOP forecast mode, he can exit from it completely (Fig. 13), returning control to the top-level menu (Fig. 1).

3.3 Accessing the Marine Fog Climatology

The second item on the top-level menu (Fig. 1) is to look up climatological fog probabilities. This feature allows the user to access AESOP's marine fog climatology directly. As in the forecast mode, AESOP requests the user to enter the latitude, longitude of the location of interest as well as the current month. The fog climatology includes monthly values for any maritime region between 70^{o} N and 70 ^{o} S with 2.5 degrees (longitude & latitude) resolution. An example of the climatology feature display is presented in Fig. 18. The user can change location or month to access fog climatology information repeatedly.

3.4 Changing the System's Units

The third selection in the top-level menu (Fig. 1) is used to tailor the AESOP units to the user's preference. AESOP considers three different types of units: 1) temperature units, 2) wind speed units, and 3) height units. Each of these items is controlled like a toggle switch (Fig. 19). If one chooses to change the temperature units, the default (degrees Celsius) is replaced by degrees Fahrenheit. Wind speeds toggle between meters per second and knots. Height units toggle between meters and feet. Once a change is made, the system continues to use the specified units in its questioning throughout the session. If the user wishes to make the changes permanent, he can tell AESOP here to do so. Of course, any changes can be modified again later if desired.

3.5 Running Test Sample Cases

The fourth choice on the top-level menu (Fig. 1) is to run the program on a series of cases in a test sample. This feature was added to assist in the development and testing of the system and is not envisioned as one a typical user would invoke. Nevertheless, if a user wishes to run many cases, he should set up a text file of answers to AESOP's questions with each case on a single line. For example, one case from the AESOP verification study (Peak, 1989) appears as follows:

"52.7,N,35.5,W,2,5,14,3,3,1,1,4,1,25,2,2,1,6.6,5.8,2,7.8,7.2,3, 3,Fog,C-14" The data begins with the latitude (52.7), hemisphere (N), longitude (35.5), hemisphere (W), coastline proximity (2=Not in seabreeze regime), month (5=May), etc., following the progression AESOP would use in interactive questioning. The set of questions AESOP asks depends sometimes on the previous answers, so it may be a bit tricky to set up these files without actually entering some cases interactively and keeping track of the answers. The next-to-last item (Fog) is the verification +6 h obscuration state. The last item is the case identification.

When running through a test sample, AESOP processes all of the cases and then lists each individual forecast followed by contingency tables such as those that appear in Peak (1989) or Peak and Tag (1989).

3.6 Exiting from AESOP

The last item in the top-level menu (Fig. 1) is to exit from AESOP. Choosing this option returns control to the operating system. Alternately, if one wishes to exit the program in the midst of execution, the PC-version responds to "Control-Break." The MASSCOMP version can be interrupted by using "Control-C."

4. ERROR MESSAGES

AESOP is designed to be self-explanatory such that the user should rarely get an error message without an accompanying action to take. However, here are some situations that might arise:

1) "Heap overflow or not enough memory." This error message usually means that there are some other programs resident in the PC memory (such as a mouse controller or graphics dump procedure). Try removing other routines from memory to give AESOP as much core as possible.

2) "Units file missing." The AESOP floppy includes a file named "units" that contains the default units specifications. Either this file has been erased or the program is being executed from another directory.

3) "Couldn't find real number X" or "Couldn't find integer number N." These errors result from an incorrect value in a file of test cases.

4) "Empty parse string" or "Trying to get Nth item in list only M long." This is another test file error. If a case has an

incorrect number of items, there will be insufficient responses for the AESOP input.

5) "Rule failed or not found: XXXXX." This error should never occur and indicates a program bug. If you get this error, please record the answers you gave to AESOP during the question/answer phase, and the rule not found, and send to the developer for corrective action.

```
W E L C O M E   T O   A E S O P

Which would you like me to do?
Make an obscuration forecast
Look up climatological fog probabilities
Change the units used for input data
Run through a test sample
Exit from AESOP
```

Figure 1. AESOP top-level menu for the PC Version.

```
W E L C O M E   T O   A E S O P
Which would you like me to do?

    1)  Make an obscuration forecast
    2)  Look up climatological fog probabilities
    3)  Change the units used for input data
    4)  Run through a test sample
    5)  Exit from AESOP
SELECT:
```

Figure 2. As in Fig. 1 except for the Masscomp version.

```
A E S O P

What is the latitude of the forecast location?

  Enter: 58.8n
```

Figure 3. AESOP request for latitude of the forecast location.

```
A E S O P

What is the longitude of the forecast location?

  Enter: 19.5w
```

Figure 4. As in Fig. 3 except for longitude.

```
The value 95 is larger than the maximum allowable value (90).

What is the latitude of the forecast location?

  Enter: 95
```

Figure 5. Example of AESOP handling an invalid response.

```
Which best describes the synoptic situation over the region?
High or Ridge
Northwest side of a High
Northeast side of a High
Low or Trough
Center of a Low
Ridge to the west & Trough to the east
Trough to the west & Ridge to the east
```

Figure 6. Example of menu-driven input.

```
During this time period (12Z - 18Z) a frontal passage
will not occur
will occur
```

Figure 7. Example of a "yes/no" question.

```
What is the inversion base height (meters) over the forecast
location?

(Enter H for hypsometric equation calculator)
  Enter: H
```

Figure 8. Selecting the hypsometric equation calculator.

Which best describes the inversion type (see the Rogers classifications)?
Type 1
Type 2
Type 3
Other
Show examples

Figure 9. AESOP request for inversion type with "Show examples" option.

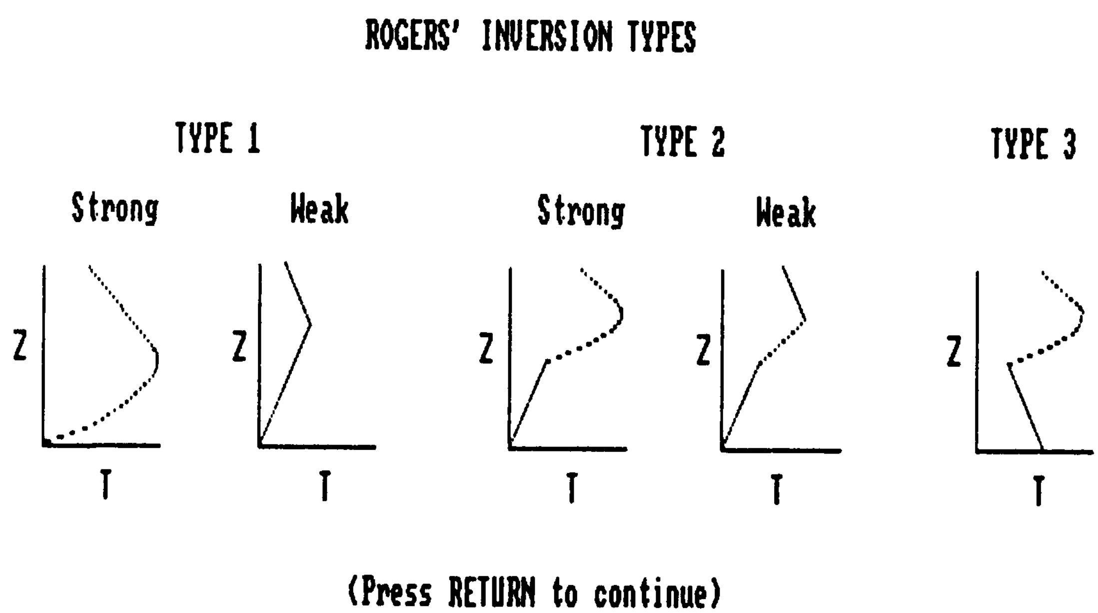

Figure 10. Inversion type examples shown by AESOP.

```
How strong is the inversion?
Strong
Moderate
Weak
```

Figure 11. AESOP request for inversion strength.

```
SUMMARY OF OBSCURATION FACTORS FOR 58.8 N, 19.5 W:

Select the data item you wish to change:
Proceed with the forecast                 Coast proximity: 500-1000 km
Month: July                               Day of month: 27
Time of day: 12Z                          Synoptic: High or Ridge
Frontal passage: will not occur           Trough passage: will not occur
Stratus: Overcast stratus                 Upper cloud cover: Clear skies
Wind speed: 3 m/sec                       Wind direction: Southerly
Synoptic flow direction: Southwesterly    Flow over SST: Warmer to colder water
Offshore flow: N/A                        Air temperature: 12.4 deg C
Dewpoint temperature: 11.6 deg C          Relative humidity: 94.9 %
Surface-only saturated: N/A               Inversion: Present
Inversion base height: 255 meters         Inversion strength: Moderate
Inversion type: Type 3                    Air above inversion: not dry
Coldest SST: 12.1 deg C                   Current obscuration: Haze
Visibility: 4 km
```

Figure 12. Example Data Summary Display.

```
AESOP NOWCAST (0-1 hours)
Nowcast for 13Z:    No Obscuration.   Prob: 100%

The sunny conditions favor dissipation of the haze.

These are the nowcasts for each potential obscuration:

    Fog.   Prob: 0%  (Climatological fog probability: 10%)
    Haze.   Prob: 0%
    No Obscuration.   Prob: 100%

                  Would you like me to
                  Display the 1-6 h forecast
                  Follow the nowcast chain of reasoning
                  Modify parameters for this case & rerun
                  Run a new case
                  Exit from AESOP forecast
```

Figure 13. Example AESOP nowcast display.

```
AESOP NOWCAST (0-1 hours)
Nowcast for 13Z:    No Obscuration.   Prob: 100%

T                    AESOP REASONING
  Each of these may occur:
T    Fog will form    Prob: 0%
     The haze will persist    Prob: 0%
     The haze will dissipate    Prob: 100%

                  Which would you like further explained?
                  Go back to previous choice
                  Exit from explanation
                  Fog will form
                  The haze will persist
                  The haze will dissipate
```

Figure 14. Example of invoking the explanation feature.

```
                         AESOP NOWCAST (0-1 hours)
Nowcast for 13Z:     No Obscuration.    Prob: 100%

T                          AESOP REASONING
 The haze will dissipate    Prob: 100%
T
 The sunny conditions favor dissipation of the haze.

 These factors must ALL contribute:
    The +1h sun is high enough to completely dissipate the haze    Prob:
 100%

 Thus, the limiting probability is 100%

           Which would you like further explained?
        Go back to previous choice
        Exit from explanation
        The +1h sun is high enough to completely dissipate the haze
```

Figure 15. Example of going one step down the reasoning chain begun in Fig. 14.

```
                         AESOP NOWCAST (0-1 hours)
Nowcast for 13Z:     No Obscuration.    Prob: 100%

T                          AESOP REASONING
 The +1h sun is high enough to completely dissipate the haze    Prob: 100%
T
 At the nowcast time, the sun angle will be 50 degrees which is high
 enough to dissipate the haze.

                Which would you like further explained?
                Go back to previous choice
                Exit from explanation
```

Figure 16. Completing the reasoning chain in Figures 14 and 15.

```
───────────────── AESOP FORECAST (1-6 hours) ─────────────────
Forecast for 18Z:    Fog.   Prob: 95%

T ──────────────────── AESOP REASONING ──────────────────────
i Fog forms by the Taylor process   Prob: 0%
c
T The Taylor fog conditions are not all met.

T These factors must ALL contribute:
     The marine layer is primed for fog   Prob: 0%
     The marine layer is cooled from below to dewpoint   Prob: 0%
     Conditions favor continued cooling from below   Prob: 100%

  Thus, the limiting probability is 0%



            ──────Which would you like further explained?─────
            Go back to previous choice
            Exit from explanation
            The marine layer is primed for fog
            The marine layer is cooled from below to dewpoint
            Conditions favor continued cooling from below
```

Figure 17. Example of reasoning involving three contributing factors.

```
Climatological fog probability for 58.8N, 19.1W in July: 10%



                    ──Would you like to──
                    Change Latitude
                    Change Longitude
                    Change Month
                    Exit from Climatology
```

Figure 18. Example fog climatology display.

```
                              A E S O P

CURRENT UNITS:
    Temperatures:  deg C
    Wind speeds:   m/sec
    Heights:       meters


                      Which would you like to do?
                      Change temperature units
                      Change wind speed units
                      Change height units
                      Permanently save units changes
                      Exit from units change
```

Figure 19. Changing the units used in AESOP.

DISTRIBUTION LIST

SPAWARSYSCOM
ATTN: PMW 141
WASHINGTON, DC 20363-5100

NOARL
ATTN: CODE 100
JCSSC, MS 39529-5004

NOARL
ATTN: CODE 125L (10)
JCSSC, MS 39529-5004

NOARL
ATTN: CODE 125P
JCSSC, MS 39529-5004

WOODS HOLE OCEANOGRAPHIC INST.
ATTN: COMPUTER OPERATIONS
P.O. BOX 32
WOODS HOLE, MA 02543

SCRIPPS INST. OF OCEANOGRAPHY
ATTN: COMPUTER OPERATIONS
BOX 6049
SAN DIEGO, CA 92106

NAVSURFWEACEN DET.
ATTN: LIBRARY
10901 NEW HAMPSHIRE AVE.
SILVER SPRING, MD 20903-5000

OFFICE OF NAVAL TECHNOLOGY
ATTN: DR. P. SELWYN, CODE 20
800 N. QUINCY ST.
ARLINGTON, VA 22217-5000

OFFICE OF NAVAL TECHNOLOGY
DR. M. BRISCOE, CODE 228
800 N. QUINCY ST.
ARLINGTON, VA 22217-5000

COMMANDER IN CHIEF
U.S. ATLANTIC FLEET
ATTN: NSAP SCIENCE ADVISOR
NORFOLK, VA 23511-5210

COMSECONDFLT
ATTN: NSAP SCIENCE ADVISOR
FPO NEW YORK 09501-6000

COMTHIRDFLT
ATTN: NSAP SCIENCE ADVISOR
PEARL HARBOR, HI 96860-7500

COMSEVENTHFLT
ATTN: NSAP SCIENCE ADVISOR
BOX 167
FPO SEATTLE 98762

COMSIXTHFLT/COMFAIRMED
ATTN: NSAP SCIENCE ADVISOR
FPO NEW YORK 09501-6002

COMNAVSURFLANT
ATTN: NSAP SCIENCE ADVISOR
NORFOLK, VA 23511

COMNAVSURFPAC
(005/N6N)
ATTN: NSAP SCIENCE ADVISOR
SAN DIEGO, CA 92155-5035

NAVAL POSTGRADUATE SCHOOL
ATTN: CODE MR
MONTEREY, CA 93943-5000

NAVAL POSTGRADUATE SCHOOL
ATTN: 0142
MONTEREY, CA 93943-5002

SPAWARSYSCOM
ATTN: CODE 312
NAT. CTR. #1
WASHINGTON, DC 20363-5100

SPAWARSYSCOM
ATTN: CODE PMW-141
NAT. CTR. #1
WASHINGTON, DC 20363-5100

NAVOCEANSYSCEN
ATTN: J. RICHTER, CODE 54
SAN DIEGO, CA 92152-5000

9HQ SAC/DOWA
ATTN: MET OPS
OFFUTT AFB, NE 68113

8 DET 18, 30 WS
ATTN: MET OPS.
APO SAN FRANCISCO 96301

SUPERINTENDENT
ATTN: USAFA (DEG)
USAF ACADEMY, CO 80840

3350TH TECH. TRNG GROUP
ATTN: TTGU/2/STOP 623
CHANUTE AFB, IL 61868

3 WW/DN
ATTN: MET OPS.
OFFUTT AFB, NE 68113

AFGL/LY
ATTN: MET. OFFICER
HANSCOM AFB, MA 01731

5WW/DN
ATTN: MET OPS.
LANGLEY AFB, VA 23665

COMMANDING OFFICER
NAVAL UNIT
ATTN: LNN/STOP 62
CHANUTE AFB, IL 61868-5000

HQ 1ST WEATHER WING/DN
ATTN: MET OPS.
HICKAM AFB, HI 96853

20 WS/DON
ATTN: MET OPS.
APO SAN FRANCISCO 96328-5000

DET. 8, 20 WS
ATTN: MET OPS.
APO SAN FRANCISCO 96239+

30 WS/DON
ATTN: MET OPS.
APO SAN FRANCISCO 96301-0420

DET. 2, 1WW/CC
ATTN: MET OPS.
APO SAN FRANCISCO 96334

DET. 5, 3WS/CC
ATTN: MET OPS.
ENGLAND AFB, LA 71303

7HQ AFSC/WER
ATTN: MET OPS.
ANDREWS AFB, MD 20331

USAFETAC/TS
ATTN: TECH. LIBRARY
SCOTT AFB, IL 62225

COMMANDER/DIRECTOR
ASL, WHITE SANDS
ATTN: SLCAS-AE
WSMR, NM 88002-5501

PACIFIC MARINE CENTER
ATTN: NAT. OCEAN CENTER, NOAA
1801 FAIRVIEW AVE., EAST
SEATTLE, WA 98102

NATIONAL MARINE FISH. SERV.
ATTN: OCEAN CLIMA. PROJECT
SOUTHWEST FISHERIES CENTER
P.O. BOX 271
LA JOLLA, CA 92037

NOAA LIBRARY
ATTN: E/AI216
7600 SAND POINT WAY N.E.
BIN C15700
SEATTLE, WA 98115-0070

NAT. CENTER OF ATMOS. RSCH.
ATTN: LIBRARY ACQUISITIONS
P.O. BOX 3000
BOULDER, CO 80302

DIRECTOR, JTWC
ATTN: MET. OPS.
FPO SAN FRANCISCO 96630

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. Agency Use Only *(Leave blank)*.	2. Report Date.	3. Report Type and Dates Covered.
	March 1991	Final

4. Title and Subtitle.
AESOP 2.1 Expert System Users Manual

5. Funding Numbers.
Program Element No. 62435N
Project No. RM35G80
Task No. 3
Accession No. DN656766

6. Author(s).
J.E. Peak

7. Performing Organization Name(s) and Address(es).
Computer Sciences Corporation, Monterey, CA 93943-5006

Naval Oceanographic and Atmospheric Research Laboratory
Atmospheric Directorate, Attn Dr. P. Tag
Monterey, CA 93943-5006

8. Performing Organization Report Number.
NOARL Technical Note 110

9. Sponsoring/Monitoring Agency Name(s) and Address(es).
Naval Ocean Systems Center (Code 54)
San Diego, CA 92152-5000

10. Sponsoring/Monitoring Agency Report Number.
NOARL Technical Note 110

11. Supplementary Notes.

12a. Distribution/Availability Statement.
Approved for public release; distribution is unlimited.

12b. Distribution Code.

13. Abstract *(Maximum 200 words).*

AESOP -- An Expert system for Shipboard Obscuration Prediction -- is a knowledge-based computer program that provides forecasts of maritime fog and haze. This users manual provides information on AESOP operation, discusses such features as the explanatory interface and the data modification/rerun options; and provides guidance on accessing AESOP's marine climatology, changing system units, and running AESOP from data sets.

14. Subject Terms.

Fog	Visibility
Haze	Artificial intelligence
Obscuration	Expert system

15. Number of Pages. 30

16. Price Code.

17. Security Classification of Report.	18. Security Classification of This Page.	19. Security Classification of Abstract.	20. Limitation of Abstract.
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	Same as report

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18
298-102